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**FINAL REPORT
MARCH 1990**

EVT 12-89

**MIL-STD-1660 TESTS
FOR
PA116 CONTAINERS ON STANDARD
40- BY 44-INCH METAL PALLETS
WITH
MODIFIED TOP PALLET ADAPTER ASSEMBLY**

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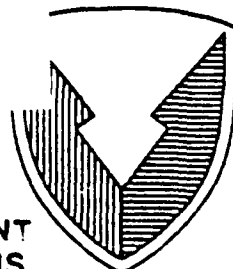
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<p>The U.S. Army Defense Ammunition Center and School (USADACS), Evaluation Division (SMCAC-DEV), was tasked by the U.S. Army Armament Research, Development and Engineering Center (ARDEC), SMCAR-AEP, Picatinny Arsenal, NJ to conduct lifting ring evaluations on the top pallet adapter assembly for PAl16 containers on metal pallets. This report contains the procedures, results, and recommendations from the MIL-STD-1660 tests conducted. As tested, the modified top pallet adapter assembly with self-nesting lifting rings, successfully passed MIL-STD-1660, Design Criteria for Ammunition Unit Loads.</p>				
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EVT 12-89

MIL-STD-1660 TESTS
FOR
PA116 CONTAINERS ON STANDARD
40- by 44-INCH METAL PALLETS WITH MODIFIED
TOP PALLET ADAPTER ASSEMBLY

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PART 1

INTRODUCTION

- A. BACKGROUND. The U.S. Army Defense Ammunition Center and School, Evaluation Division, was tasked by ARDEC, SMCAR-AEP, to test the top pallet adapter assembly and lifting rings for palletized PAl16 containers. These tests were initiated after several field lifting rings failed during material handling operations. Changes to the new adapter assembly included increasing the lateral strength of the top frame and stronger lifting rings
- B. AUTHORITY. This test was conducted in accordance with mission responsibilities delegated by the U.S. Army Armament, Munitions and Chemical Command (AMCCOM), Rock Island, IL.
- C. OBJECTIVE. The objective of this series of tests was to assess the strength of the modified top pallet adapter assembly and lifting rings in meeting the minimum MIL-STD-1660, Design Criteria for Ammunition Unit Loads.

PART 2

ATTENDEES

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PART 3

TEST PROCEDURES

The test procedures outlined in this section were extracted from MIL-STD-1660, Design Criteria for Ammunition Unit Loads, 8 April 1977. This standard identifies nine steps that a unitized load must undergo if it is to be considered acceptable. The five tests that were conducted on the test pallets are summarized below.

A. STACKING TESTS. The unit load shall be loaded to simulate a stack of identical unit loads stacked 16 feet high, for a period of one hour. This stacking load is simulated by subjecting the unit load to a compression weight equal to an equivalent 16-foot stacking height. The compression load is calculated in the following manner. The unit load weight is divided by the unit load height in inches and multiplied by 192. The resulting number is the equivalent compressive force of a 16-foot-high load.

B. REPETITIVE SHOCK TEST. The repetitive shock test shall be conducted in accordance with Method 5019, Federal Standard 101. The test procedure is as follows: The test specimen shall be placed on, but not fastened to, the platform. With the specimen in one position, vibrate the platform at 1/2-inch amplitude (1-inch double amplitude) starting at a frequency of about 3 cycles per second. Steadily increase the frequency until the package leaves the platform. The resonant frequency is achieved when a 1/16-inch-thick feeler gage may be momentarily slid freely between every point on the specimen in contact with the platform at some instance during the cycle or a platform acceleration achieves 1 ± 0.1 G's. Midway into the testing period the specimen shall be rotated 90 degrees and the test continued for the duration. Unless failure occurs, the total time of

vibration shall be two hours if the specimen is tested in one position; and, three hours for more than one position.

C. EDGEWISE ROTATIONAL DROP TEST. This test shall be conducted by using the procedures of Method 5008, Federal Standard 101. The procedure for the Edgewise Rotational Drop Test is as follows: The specimen shall be placed on its skids with one end of the pallet supported on a beam 4 1/2 inches high. The height of the beam shall be increased, if necessary, to ensure that there will be no support for the skids between the ends of the pallet when dropping takes place, but should not be high enough to cause the pallet to slide on the supports when the dropped end is raised for the drops. The unsupported end of the pallet shall then be raised and allowed to fall freely to the concrete pavement, or similar underlying surface from a prescribed height. Unless otherwise specified, the height of drop for level A protection shall conform to the following tabulation.

<u>GROSS WEIGHT</u> <u>NOT EXCEEDING</u>	<u>DIMENSIONS ON ANY</u> <u>EDGE NOT EXCEEDING</u>	<u>HEIGHT OF DROP</u> <u>LEVEL A PROTECTION</u>
600 lbs.	72 inches	36 inches
3,000 lbs.	no limit	24 inches
no limit	no limit	12 inches

D. SLING COMPATIBILITY TEST. Unit loads utilizing special design for nonstandard pallets shall be lifted, slung, lowered, and otherwise handled as necessary using slings of the types normally used for handling the unit loads under consideration. Slings shall be easily attached and removed. Danger of slippage or disengagement when the load is suspended shall be cause for rejection of the unit load.

E. IMPACT TEST. This test shall be conducted by using the procedure of Method 5023, Incline-Impact Test of Federal Standard 101. The procedure for the Incline-Impact Test is as follows: The specimen shall be placed on the carriage with the surface or edge which is to be impacted projecting at least 2 inches beyond the front end of the carriage. The carriage shall be brought to a predetermined position on the incline and released. If it is desired to concentrate the impact on any particular position on the container, a 4- by 4-inch timber may be attached to the bumper in the desired position before the test. No part of the timber shall be struck by the carriage. The position of the container on the carriage and the sequence in which surfaces and edges are subjected to impacts may be at the option of the testing activity and will depend upon the objective of the tests. When the test is to determine satisfactory requirements for a container or pack and, unless otherwise specified, the specimen shall be subjected to one impact on each surface that has each dimension less than 9.5 feet. Unless otherwise specified, the velocity at time of impact shall be 7 feet per second.

PART 4

TEST EQUIPMENT

A. TEST PALLET

a. Drawing	AC200000501
b. Width:	40 inches
c. Length:	44-1/2 inches
d. Height:	52-5/8 inches
e. Weight:	2,400 pounds

B. COMPRESSION TESTER.

a. Manufacturer:	Ormond Manufacturing
b. Platform:	60 inches by 60 inches
c. Compression Limit:	50,000 pounds
d. Tension Limit:	50,000 pounds

C. TRANSPORTATION SIMULATOR.

a. Manufacturer:	Gaynes Laboratory
b. Capacity:	6,000-pound pallet
c. Displacement:	1/2-inch Amplitude
d. Speed:	50 to 400 rpm
e. Platform:	5 foot by 8 foot

D. INCLINED RAMP.

a. Manufacturer:	Conbur Incline
b. Type:	Impact Tester
c. Grade:	10 percent Incline
d. Length:	12-foot Incline

PART 5

TEST RESULTS

MIL-STD 1660 TESTS

All pallets tested used modified unitization procedures, which included unitization of the top three rows of containers with two 3/4-inch bundling straps, as well as the third, fourth, and fifth layers being unitized in a like manner. The containers in contact with the pallet were not unitized as per standard unitization procedures. Three 1 1/4-inch unitization straps were used to band the top pallet adapter to the pallet as per standard procedures.

A. STACKING TEST. Three pallets were tested with a load weight of 12,000 +/- 500 pounds and compressed for a period of one hour. No damage was noted to any pallets during this test.

B. REPETITIVE SHOCK TEST. All pallets were tested during the first 90 minutes of vibration with the pallet skids longitudinal to the induced dynamic load. The test equipment during this cycle was operated between 175 and 190 revolutions per minute (rpm) to achieve the required 1/16-inch minimum clearance. The second 90 minutes of vibration were between 155 and 185 rpm with the pallet skids oriented lateral to the induced dynamic load. At the end of testing, minor pallet deck cracks were noted at points of contact with the skid supports on pallet one, no damage was noted on pallet two and minor damage to the top pallet adapter assembly was noted at points of contact with the shaker table frame on pallet three.

C. EDGEWISE ROTATIONAL DROP TEST. The first drop to all pallets was perpendicular to the skids with this process repeated in a clockwise direction until all four sides of the pallet had been tested. The PAll6 stacking lugs popped out of the top adapter assembly during impacts parallel to the skids.

but returned to nested position after impacts perpendicular to the skids on pallet one. On pallets two and three several container stacking lugs were misaligned with the top pallet adapter at completion of this test.

D. IMPACT TEST. The incline plane was set to allow the pallets to travel 8 feet prior to impacting a stationary wall. The pallets were rotated clockwise after each impact until all four sides had been tested. At completion of this test, no damage was noted to pallet one, several PALL6 stacking lugs were disengaged on pallet two, with no damage or disengagement noted to pallet three.

E. SLING TEST. The sling test consisted of four different lifting configurations using the top adapter assembly and a four-legged sling. The sling configurations included a three corner, two alternate corners, two adjacent corners, and a single corner lift. Pallet one had minor permanent deformation to the ring support which resulted in non-nesting after the single corner lift. No damage was noted on pallets one and three after this test.

PART 6

CONCLUSION & RECOMMENDATIONS

A. CONCLUSION.

The modified top adapter assembly with new lifting rings passed MIL-STD-1660, Design Criteria for Ammunition Unit Loads after modifications to the standard unitization procedures were made. All pallets tested had stacking lug disengagement with the top pallet adapter assembly due to mating part tolerances of the items being tested, but returned to their proper nested configuration upon completion of the MIL-STD 1660 tests.

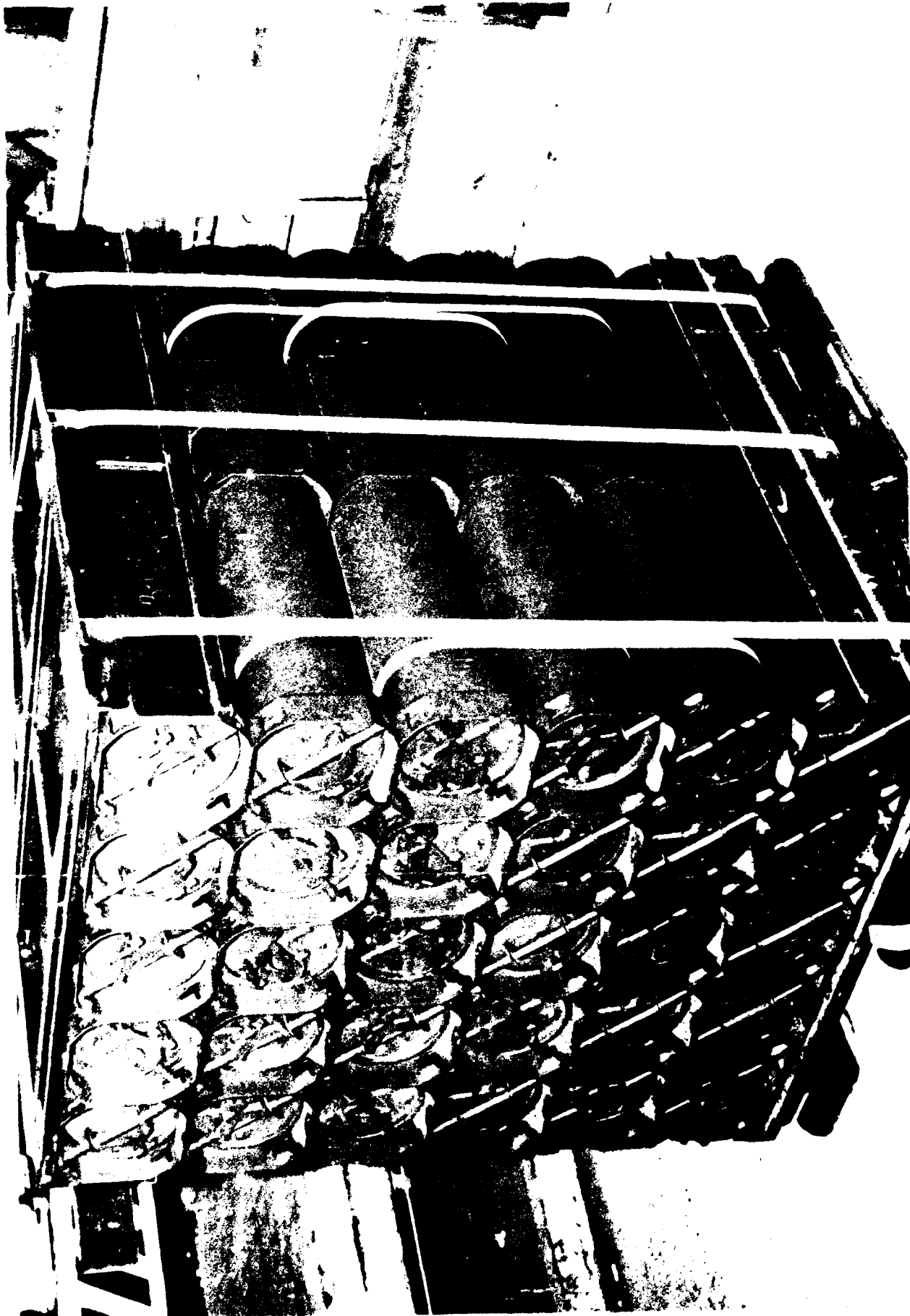
B. RECOMMENDATIONS.

(1) Increase the mating part tolerances for the slots provided on the top pallet adapter assembly for container stacking lugs. This will avoid disengagement as repeatedly demonstrated during this series of tests.

(2) That 19-48 series unitization drawings depicting unitization procedures for the PAll6 containers on metal pallets be changed to include bundling of the top three layers of containers, in lieu of that currently depicted within the drawings.

PART 7

PHOTOGRAPHS



89-2442

DEFENSE AMMUNITION CENTER AND SCHOOL SAVANNA, IL

Photo No. 1 This photo shows palletized Pall6 containers with standard unitization procedures and modified top pallet adapter assembly.



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DEFENSE AMMUNITION CENTER AND SCHOOL SAVANNA, IL

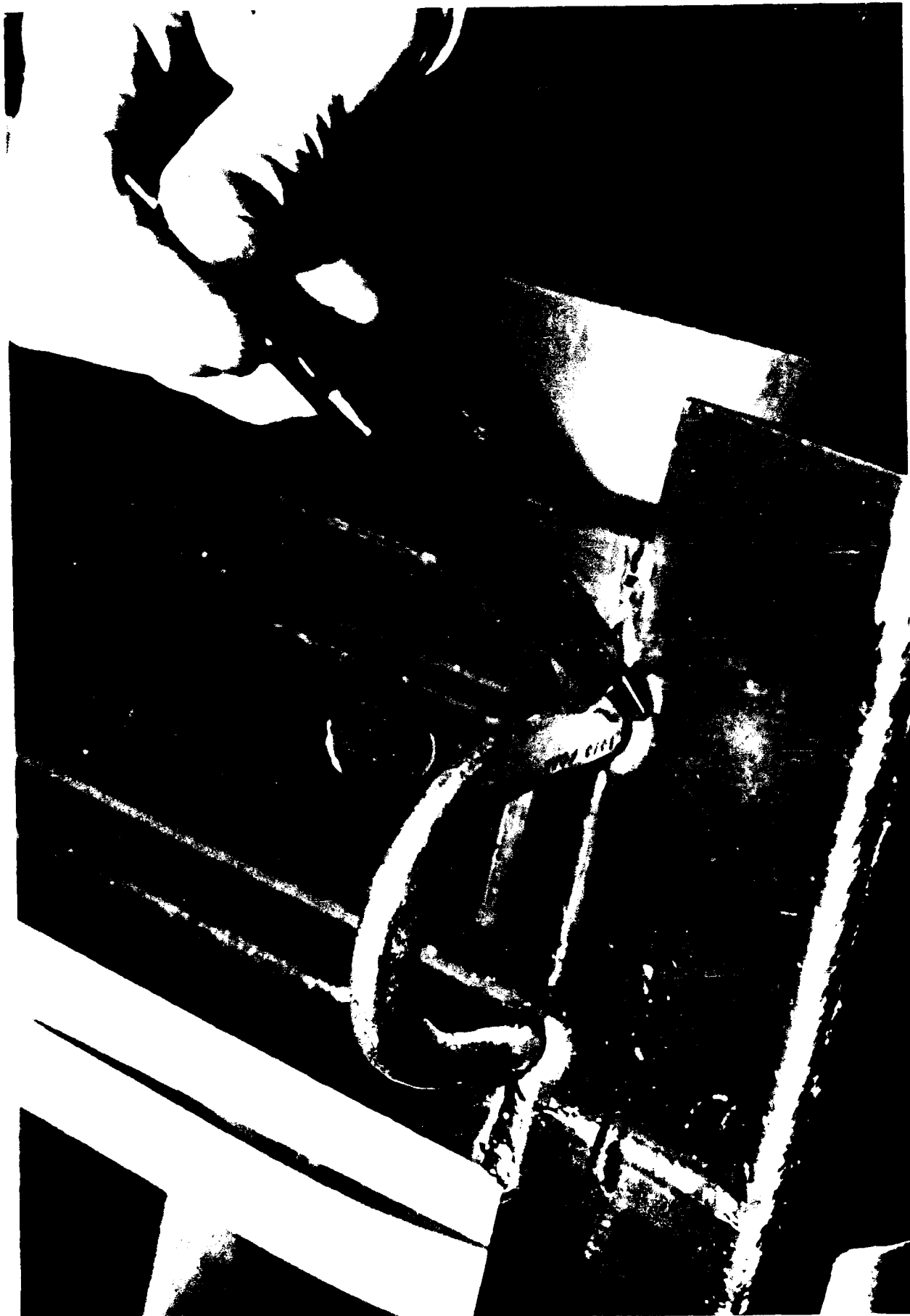
Photo No. 2 This photo shows a modified top pallet adapter with new unitization procedures. Note 3/4-inch metal strapping over the top layer of containers.



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Photo No. 3 This photo shows the misalignment of stacking lug with the top pallet adapter.



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Photo No. 4 This photo shows a permanent deformation to the lifting ring support assembly.